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Case Report

Paediatrics Section

Impact of Swiss Ball Stabilisation Training Combined with Strength Training in a Five-Year-Old Child with Spastic Diplegic Cerebral Palsy: A Case Report

SHRIKRISHNA GANGADHAR SHINDE[1], MOHD IRSHAD QURESHI[2]

ABSTRACT

Spastic Diplegic Cerebral Palsy (SDCP) is a common form of cerebral palsy that predominantly affects the lower limbs, often resulting in stiffness, spasticity, and functional limitations. Conventional rehabilitation typically emphasises mobility and strengthening exercises; however, recent evidence suggests that incorporating core stabilisation strategies has been shown to enhance outcomes. This case report describes a five-year-old child with SDCP, classified as Gross Motor Function Classification System (GMFCS) Level III. The child underwent a 6-week physiotherapy programme, consisting of three sessions per week that combined Swiss ball–based stabilisation training with hip and knee extensor strengthening. The primary outcome measures were the Paediatric Balance Scale (PBS), Gross Motor Function Measure-88 (GMFM-88), and Cerebral Palsy Quality of Life Questionnaire (CP-QOL). Following intervention, the PBS improved from 25 to 32, GMFM-88 from 58% to 74%, and CP-QOL from 20 to 38, reflecting notable gains in balance, gross motor abilities, and quality of life. These findings suggest that the integration of Swiss ball stabilisation and strength training can positively influence motor performance and participation in children with SDCP. This report highlights the potential value of incorporating stabilisation techniques into paediatric rehabilitation and supports further research into their clinical applicability.

Keywords: Core stability, Exercise therapy, Gait, Paediatric neurorehabilitation, Postural control, Rehabilitation

CASE REPORT

A five-year-old girl was brought to the neurophysiotherapy outpatient department by her parents with the chief complaint of delayed walking and difficulty performing age-appropriate gross motor activities. She was born preterm at 28 weeks of gestation with a birth weight of 1.2 kg. She required four weeks of neonatal intensive care due to respiratory distress. The mother had gestational diabetes (managed with diet) but no other comorbidities. Mother took routine prenatal iron and folic acid supplements, with no exposure to teratogenic drugs or infections. There was no family history of similar neurological disorders or hereditary spastic paraplegia. The child has demonstrated delayed attainment of motor milestones since early childhood. At two years of age, she was diagnosed with SDCP based on clinical findings and Magnetic Resonance Imaging (MRI) evidence of Periventricular Leukomalacia (PVL). Her parents reported that the child had functional issues for almost four years, during which time her restrictions were first overlooked. She had received occasional conventional physical therapy before coming to the institution, which mostly consisted of stretching and simple mobility exercises, without a structured programme aimed at progressive muscle building or core stabilisation.

At presentation, she was unable to stand or ambulate independently and required walking aids for mobility. The child had an ectomorphic body build and was well-oriented to time, place, and person. On observation, she was seated in a high sitting position with the hips and knees flexed to 90°, and ankles in plantarflexion. Impairments were noted in bilateral lower limbs and trunk control. The child was categorised as GMFCS Level III at the time of assessment [1]. The lower limb musculature showed mild to moderate spasticity on both sides, according to an evaluation of muscle tone using the Modified Ashworth Scale [2]. The hip flexors, knee extensors, and ankle plantar flexors showed a slight rise in tone (grade 1+), whereas the hip extensors, knee flexors, and ankle dorsiflexors on both sides showed grade 1 spasticity [Table/Fig-1]. These results are consistent with the clinical manifestation of SDCP and show primarily modest stiffness affecting the lower limbs. Exaggerated deep tendon reflexes bilaterally, with knee and ankle jerks, were graded 3+ (brisk with clonus), alongside positive Babinski signs on both sides, indicating upper motor neuron involvement typical of SDCP. Biceps, triceps, and supinator jerks were normal (2+), reflecting selective lower limb and pyramidal tract hyperactivity due to PVL [Table/Fig-2]. Manual muscle testing was used to assess muscle strength. The findings revealed bilateral muscle weakness graded between 2 and 3, with greater involvement of the hip and knee extensors and ankle muscles, confirming predominant proximal lower-limb involvement typical of SDCP [Table/Fig-3]. The assessment supported the need for focused strengthening intervention by showing increased weakness in the proximal lower limb musculature, especially the hip and knee extensors. Functionally, the child needed walking assistance to walk and had trouble standing unassisted. During both static and dynamic exercises, balance was compromised.

Muscle group	Right	Left
Hip flexors	1+	1+
Hip extensors	1	1
Knee flexors	1	1
Knee extensors	1+	1+
Ankle plantar flexors	1+	1+
Ankle dorsiflexors	1	1

[Table/Fig-1]: Assessment of tone.

Reflexes	Right	Left
Plantar response	Positive Babinski sign	Positive Babinski sign
Biceps jerk	2+	2+
Triceps jerk	2+	2+

Supinator jerk	2+	2+
Knee jerk	3+	3+
Ankle jerk	3+	3+

[Table/Fig-2]: Assessment of reflexes.

Muscle	Right	Left
Shoulder		
Flexors	3+	3+
Extensors	3+	3+
Abductors	3+	3+
Adductors	3+	3+
External rotators	3+	3+
Internal rotators	3+	3+
Elbow		
Flexors	4	4
Extensors	4	4
Forearm		
Pronators	3	3
Supinator	3	3
Wrist		
Flexors	3+	3+
Extensors	3+	3+
Hip		
Flexors	3	3
Extensors	2+	2+
Abductors	2+	2+
Adductors	2+	2+
External rotators	2+	2+
Internal rotators	2+	2+
Knee		
Flexors	3	3
Extensors	2+	2+
Ankle		
Plantar flexors	2+	2+
Dorsi flexors	2+	2+
Invertors	2+	2+
Evertors	2+	2+

[Table/Fig-3]: Elicits muscle strength.

MRI revealed PVL, consistent with the clinical presentation of SDCP. The clinical findings and imaging confirmed the diagnosis of SDCP, GMFCS Level III [2].

A 6-week rehabilitation programme was designed for the child, consisting of three sessions per week. The programme combined Swiss ball-based stabilisation exercises with strength training of the hip and knee extensors.

Functional outcomes were evaluated using the PBS [3], GMFM-88 [4], and CP-QOL [5]. The specific exercises are summarised in [Table/Fig-4] [6,7], and the interventions are illustrated in [Table/Fig-5a-c]. The PBS was used to assess functional balance during sitting, standing, and transitional movements, with higher scores indicating

Swiss ball stabilisation training exercises			
S. No.	**Exercises**	**No. of repetitions**	**Sets**
1	Making the child bounce on the Swiss ball actively/passively	5 times	5 sets
2	Position the child to sit on the ball and rotate the child on either of the sides as shown in Figure B. This will facilitate trunk rotation by which the upper body is towards the weight-bearing hip.	7 reps on each side	1 set
3	Positioning the child to sit on the ball with the lower extremities in a dissociated position, as shown in Figure c. Move the ball forward and backward diagonally. This will facilitate pelvic femoral rotation and controlled use of flexors and extensors across the body, which leads to equilibrium control in the trunk and hips.	5 times	5 sets
4	Make the child sit on the ball and work on a trunk rotation with a stable pelvis and hip by giving reaching activities as shown in Figure D. An activity on reaching in different directions allows the child to work the trunk and lateral weight shifting.	5 reps on each side	1 set
5	Position the child supine on the ball with the feet on the floor, as shown in Figure E. Hold through the lower abdominals to stabilise them onto the ball. Now, facilitate using one arm and bring the child diagonally up to a stance.	10 reps on each side	1 set
Exercises for Strength Training.			
6	For hip extensors, the subject will be lying prone, the weight cuff will be placed just above the knee joint, and the subject will be asked to lift the thigh with the weight to full extension.	10 reps	1 set
7	For knee extensors, the subject will be sitting, the weight cuff will be placed above the ankle joint, and the subject will be asked to extend the knee with weight.	10 reps	1 set
Duration: 1 hour/day, 3 sessions/ week, for 6 weeks.			

[Table/Fig-4]: Treatment protocol [6,7].

[Table/Fig-5a]: Swiss ball-based stabilisation exercise.

[Table/Fig-5a]: Swiss ball-based stabilisation exercise.

[Table/Fig-5c]: Lower limb strengthening exercises for the hip.

better balance control. Gross motor abilities were measured using the GMFM-88, which evaluates performance across domains such as lying, sitting, crawling, standing, and walking, where higher percentage scores reflect improved gross motor function. Quality of life was assessed using the CP-QOL, which captures caregiver-perceived participation, physical health, social well-being, pain, and emotional well-being, with higher scores representing a better perceived quality of life. Assessments were conducted at baseline (pre-treatment), immediately after completion of the 6-week intervention, and at 12-week follow-up. The follow-up assessment demonstrated maintenance of improvements in balance and further gains in gross motor function and quality of life, indicating retention of therapeutic benefits beyond the supervised intervention period [Table/Fig-6]. During the intervention and follow-up period, the child did not receive any additional physiotherapy, occupational therapy, or alternative rehabilitation interventions apart from the prescribed study protocol.

Outcome	Pre	Post-6 weeks	Follow-up 12 weeks
PBS Total	25	32	32
GMFM-88: Standing (D)	40	55	58
GMFM-88: Walking (E)	30	48	52
GMFM-88 Total	58	74	78

[Table/Fig-6]: Elicits the results.

Paediatric Balance Scale (PBS): The PBS score improved from 25 to 32 post-intervention, reflecting enhanced balance control and postural stability. Follow-up at 12 weeks showed maintenance of this improvement. The dynamic core engagement provided by Swiss ball exercises likely contributed to these gains.

Gross Motor Function Measure-88 (GMFM-88): The GMFM-88 score increased from 58 to 74 after the intervention, particularly in the standing and walking domains. Follow-up at 12 weeks showed a score of 78, indicating sustained improvement. Targeted lower limb strengthening contributed to better transitions, standing, and ambulatory ability.

Cerebral Palsy Quality of Life (CP-QOL): The CP-QOL score improved from 20 to 38 post-intervention, and follow-up at 12 weeks showed a score of 40, indicating enhanced perceived quality of life. Improvements in motor function and engagement in enjoyable exercises likely enhanced social participation and emotional well-being.

On the PBS, improvements were primarily observed in standing balance, transitional movements, and dynamic tasks requiring postural control. On the GMFM-88, the most notable gains were seen in the standing (Dimension D) and walking, running, and jumping (Dimension E) domains. Improvements in the Cerebral Palsy Quality of Life Questionnaire were predominantly noted in caregiver-perceived participation, physical well-being, and emotional well-being domains [Table/Fig-7].

Outcome measure	Domain	Pre (Week 0)	Post (Week 6)	Follow-up (Week 12)
CP-QOL Total		20	38	40
	Participation and social	3	7	8
	Physical well-being	4	8	9
	Emotional well-being	3	7	7
	Pain & hurt	4	5	5
	Access to services	2	4	4
	Family health	2	4	4
	Communication	2	3	3

[Table/Fig-7]: Domain-wise CP-QOL Scores across assessment periods.

DISCUSSION

The SDCP is one of the most common subtypes of cerebral palsy and is primarily attributed to injury to the immature periventricular white matter, most commonly in the form of PVL [8]. This pattern of brain injury is strongly associated with prematurity, low birth weight, hypoxic-ischaemic insults, and neonatal complications such as respiratory distress and infection [9]. Damage to the corticospinal tracts supplying the lower limbs results in predominant spasticity and motor impairment of the legs, with relative preservation of upper limb function and cognition in many affected children [8,10].

Globally, cerebral palsy affects approximately 2-3 per 1,000 live births, with spastic diplegia accounting for nearly 30-40% of cases, particularly among children born preterm [10,11]. Despite improvements in neonatal care and survival of very preterm infants, the prevalence of SDCP related to white matter injury remains substantial [9].

The differential diagnosis of SDCP includes spastic hemiplegic cerebral palsy, spastic quadriplegic cerebral palsy, hereditary spastic paraplegia, and other progressive neurometabolic or neurodegenerative disorders [12]. Spastic hemiplegia is characterised by unilateral motor involvement, whereas spastic quadriplegia presents with involvement of all four limbs and is often associated with significant cognitive and sensory impairments. Hereditary spastic paraplegia differs from cerebral palsy in its genetic aetiology, progressive course, and later onset, while cerebral palsy is non-progressive and associated with early brain injury supported by characteristic neuroimaging findings such as PVL [12,13]. In the present case, spastic hemiplegic cerebral palsy was ruled out due to the absence of unilateral involvement, and spastic quadriplegic cerebral palsy was excluded because all four limbs were not affected and cognitive function was preserved. Due to its progressive character, later onset, and genetic aetiology, hereditary spastic paraplegia was also excluded. The diagnosis of SDCP was supported by the child's early, non-progressive presentation and imaging findings of PVL. Prognosis, family counseling, and effective management planning all depend on accurate distinction. Children with SDCP have impaired trunk control, which limits their functional independence and participation by negatively affecting postural stability, balance, and gait [14]. Task-specific, activity-based therapies that focus on lower limb strength and trunk stability are the focus of modern physiotherapy management. Combined trunk stabilisation and strengthening regimens have been shown to improve postural control, functional mobility, and participation outcomes, eventually improving the quality of life for children with cerebral palsy [15]. Core stabilisation training using a dynamic surface likely improved

postural control by enhancing trunk muscle activation, anticipatory postural adjustments, and proximal stability. Improved trunk stability provides a stable base for lower limb movements, facilitating better balance, standing control, and functional mobility in children with SDCP [14].

Several studies support this approach. When compared to hippotherapy simulators, Swiss ball-based therapy greatly enhanced functional independence and postural balance in children with SDCP, according to Jaiswal D et al., [6]. In children with spastic cerebral palsy, Reddy S and Balaji GK showed that dynamic surface exercise training enhanced trunk control and gross motor function, demonstrating the value of unstable surface training in promoting postural changes [16]. In children with spastic diplegia, Kim JH and Seo HJ showed that trunk-hip strengthening exercises significantly improved standing balance and postural alignment [17]. Furthermore, Hazar Z et al., found that core stabilisation training with a Swiss ball enhanced a kid with cerebral palsy's sitting balance and transitional movements, highlighting both clinical viability and child engagement [18]. Additionally, it has been demonstrated that strength training is essential for enhancing functional outcomes for patients with cerebral palsy. In children with spastic bilateral cerebral palsy, Pouliot-Laforte A et al., showed a good correlation between walking ability and lower limb strength [19]. According to Gurusamy L et al., functional strength training outperformed traditional physiotherapy in terms of improving gross motor function [20]. Aye T et al., demonstrated that children with SDCP had improved muscle strength and movement by targeted hip and knee extensor strengthening [7]. Therefore, trunk control, balance, standing capacity, and ambulation may have benefited from the combined application of Swiss ball stabilisation and lower limb strengthening in the present case, with gains sustained at follow-up.

CONCLUSION(S)

The combined use of Swiss ball-based trunk stabilisation and lower limb strengthening led to significant improvements in balance, gross motor function, and QoL in a child with SDCP. These improvements were maintained or further enhanced at follow-up, indicating retention of functional gains. This approach is considered as an effective adjunct to individualised physiotherapy programmes for children with SDCP.

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PARTICULARS OF CONTRIBUTORS:
1. PhD Scholar, Department of Physiotherapy, Ravi Nair Physiotherapy College, Wardha, Maharashtra, India.
2. Principal, Department of Physiotherapy, Ravi Nair Physiotherapy College, Wardha, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Shrikrishna Gangadhar Shinde,
PhD Scholar, Department of Physiotherapy, Ravi Nair Physiotherapy College, Wardha-442107, Maharashtra, India.
E-mail: krishnashinde12989@gmail.com

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